THE INVASION OF *PIPER ADUNCUM* IN PAPUA NEW GUINEA: FRIEND OR FOE?

by A E Hartemink

About 75% of the landmass of Papua New Guinea is covered with primary forest which is assumed to have a high biodiversity. Overall there has been little decrease in the area under primary forest although some decrease results from logging activities and expansion of plantation agriculture. Shifting cultivation is the main form of agricultural land-use but due to intensification of the agricultural systems there has been little extension into primary forest areas. There are large areas in the humid lowlands where *Piper aduncum* L., a native from Central America, has invaded forming locally monospecific stands. Despite *P. aduncum*'s rapid invasion and widespread occurrence very little research has been conducted on its invasion and effects.

The invasion

Many parts of the tropics have been invaded with new plant and animal species which may have devastating effects on native ecosystems. Animals have received relatively more attention than plants, but the introduction of plants can be devastating as well. An example which has recently gained research attention in Africa and Asia is the small shrub *Chromolaena odorata* L., a native of Central and South America which was brought to Asia in the late 19th century. It has spread rapidly across Asia and arrived in Africa in the 1940s where it is suppressing the native regrowth in shifting cultivation systems. An example from the Pacific is *Miconia calvescens* DC which was introduced in Tahiti in 1936 where it now called the 'green cancer'. *Miconia* has become a major plant pest in the Society Islands of French Polynesia. Invasion of plant species has also been reported by other workers from Mauritius, and Hawaii.

In Papua New Guinea, the tall shrub *Piper aduncum* L., that originates from South America now dominates much of the secondary fallow vegetation. It occurs widely in the Morobe and Madang Provinces at altitudes up to 600 m asl, and is found in the highland provinces up to altitudes of 1800 m asl. *P. aduncum* is frequently observed along logging tracks and on fallow sites where it often forms monospecific stands. It occurs in soil seed banks and appears to be fast growing.

P. aduncum is indigenous to tropical America where it is found from Mexico to Bolivia. Its habitat in Central America is restricted to evergreen vegetation and near watercourses in seasonally deciduous forests, from sea level to about 1500 m asl. *P. aduncum* was introduced in Indonesia in 1860, and is now commonly found in Irian Jaya and Malaysia. In the Pacific it occurs in Fiji but is not found in Hawaii or Northern Australia where it is on the quarantine list. It is unknown how and when *P. aduncum* arrived in Papua New Guinea but it was firstly described in the Morobe Province in 1935. It was not listed in the standard work on Papua New Guinea

Vegetation by Paijmans from 1976 and its rapid spread occurred in the past two to three decades. Most farmers clearly remember when they observed *P. aduncum* for the first time in their fields.

Research in progress

In 1996 we started a series of experiments with *P. aduncum* in the humid lowlands (about 3000 to 4500 mm rain/year) in order to investigate reasons for its spreading and the effects on soil and crop productivity in shifting cultivation systems. We conducted (i) a seed bank study, (ii) measured the rate of height growth and nutrient and biomass accumulation, (iii) studied the chemical composition and decomposition pattern of its leaves, and (iv) quantified the effects on soil properties and agricultural crops following the fallow. Not all of the data have been analysed yet but some of the results are discussed here. Large numbers of viable *P. aduncum* seeds occurred in forest and fallow soils and the seed bank occurred in numbers greater than other species conferring a competitive advantage during regeneration. Two-year old *P. aduncum* shrubs were 4.5 m high and had accumulated nearly 50 t/ha of dry matter (DM). It was found that the growth rate of *P. aduncum* both in biomass and height is favoured by high rainfall. Highest growth rates were 134 kg DM/ha/day and it seems that the humid conditions in combination with the relatively fertile soils in the Papua New Guinea lowlands favour rapid growth. Total nutrient accumulation after one year was 120 kg N, 22 kg P, 298 kg K and 157 kg Ca per hectare. We further found that *P. aduncum* fallows had no strong effect on sweet potato yield compared to other fallow vegetation. However, soils were significantly drier under *P. aduncum* fallows and the data confirm what most farmers say about *P. aduncum* i.e., that it depletes soil moisture.

Friend or foe?

It is generally assumed that exotic species might more easily invade in areas of low species diversity than areas of high species diversity because of more complete use of the resources by high species diversity. The lowland rain forests of Papua New Guinea have a very high biodiversity and therefore *P. aduncum* must have a competitive advantage over the native species explaining its rapid invasion. Our research suggests that its advantage is related to its extremely fast growth enabling it to quickly outgrow associated pioneer tree species. This may imply a loss of biodiversity. The spreading of *P. aduncum* largely occurred through logging, shifting cultivation and forest fires, which were particularly severe in the 1997/98 El Niño Southern Oscillation. *P. aduncum* has the ability to resprout once damaged, which is a trait that would favour persistence in disturbance-prone environments where the vegetation is not completely removed. *P. aduncum's* presence in small gaps in closed forest, and its proliferation on frequently disturbed fallow sites suggest it has a catastrophic and gap-phase regeneration pattern. Catastrophic natural disturbances, such as landslides or stand-devastating wind-throw which are not uncommon in the lowlands, are another possibility for the spreading of *P. aduncum*.

There are also some advantages. First, it grows very fast and we have never observed soil erosion under *P. aduncum*. It also accumulates large amounts of

potassium which becomes available to agricultural crops when the vegetation is slashed and decomposed. It has been observed that locally man-made grasslands (mainly *Imperata cylindrica*) have reverted to bush fallow vegetation. Farmers prefer woody regrowth above grasslands as it provides firewood and it also provides better soil cover. Another possible advantage is that research in C and S America has shown that *P. aduncum* has ethno-pharmacological properties which have not been explored in Papua New Guinea. However, much of the natural vegetation it replaces may also have such properties.

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